METHOD

OF

ASSAYING and CLASSING

MINERAL SUBSTANCES.

BRITISH MUSEUM

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AN EASY METHOD OF ASSAYING and CLASSING MINERAL SUBSTANCES,

CONTAINING

PLAIN AND EASY INSTRUCTIONS

FOR ANY PERSON TO EXAMINE
The PRODUCTS of his own Land, or ſuch as are obvious
in Excurſions or Travels in foreign Countries, with-
out having a complete Chemical Apparatus.

TO WHICH IS ADDED,

A SERIES OF EXPERIMENTS ON THE *Fluor Spatoſus*, or Sparry Fluor.

ABSTRACTED FROM THE
Memoirs of the ROYAL SWEDISH ACADEMY of
SCIENCES for the Year 1771.

By JOHN REINHOLD FORSTER, F. R. S.

> *Multa ſunt quæ eſſe concedimus: qualia ſint ignoramus.*
> SENECA, Nat. Quæſt. l. vii. c. 24.

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AN
EASY METHOD
OF
ASSAYING and CLASSING MINERAL SUBSTANCES OF ALL KINDS.

SECTION I.

Giving an account of the neceſſary Apparatus and Precautions in making the various Experiments hereafter mentioned.

AS it is my intention to make Aſſaying as eaſy as poſſible, that even a man with moderate parts may be enabled to claſs all the Mineral Subſtances he meets with, either on his own eſtate or in his travels, we have been obliged to confine ourſelves to a very ſmall apparatus. This could have been ſtill more compendious, had we thought it proper to adopt Mr. *Engſtroem*'s *Pocket Laboratory* *, which chiefly depends upon the dexterous management of the blowing-pipe, requires a great deal of experience and ſkill, and will certainly be prejudicial to the breaſts of ſuch gentlemen as have any complaints relative to their lungs. Beſide theſe objections, the habit of properly managing this inſtrument cannot be eaſily acquired in a certain age; and, if great precautions are not taken, an operator is apt to ſwallow the fumes which ariſe from the operation, and which are often arſenical, or otherwiſe noxious. We have therefore taken all poſſible care to avoid any ſuch operations as would require a great deal of trouble, or a larger apparatus than may be taken on a journey or voyage without too much incumbrance. Upon the whole, it would not be amiſs to take Mr. Engſtroem's apparatus, as it contains a great variety of inſtruments we muſt likewiſe recommend; viz. a hammer, a ſteel to ſtrike fire with, a loadſtone, a file, a ſteel plate to hammer and pound ſubſtances on, a magnifying-glaſs, a ſmall mattraſs, a trough for waſhing the ores, &c. The only additions we ſhould chuſe to make, would be a ſmall box containing ſome phials with the following liquids; viz. Three phials with the concentrated acids of vitriol, marine ſalt, and ſaltpetre, together with one phial full of aqua regis, which is a compound of two-thirds of acid of nitre and one-third of muriatic acid, or in ſome caſes of equal parts of each of the above acids; 2. A ſolution of ſalt of tartar; 3. Spirit of hartſhorn, or a volatile alkali; 4. A phial with *liquor vini probatorius* *; 5. Some oil of olives, or lin-

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* At the end of the Engliſh tranſlation of Cronſtedt's Mineralogy.

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[*] Take one ounce of orpiment, two ounces quick-lime, twelve ounces diſtilled water, infuſe the above ſubſtances with the water, digeſt the infuſion in a cloſe glaſs, in a moderately warm place, ſhake it often during twenty-four hours, let it cool, decant it, keep it in a well ſtopped glaſs; this is *liquor vini probatorius*.

ſeed, which is better; 6. A piece or ſome pounded quick-lime, in a well-ſtopped glaſs, in order to make occaſionally a ſolution of quick-lime; 7. A phial with quickſilver; 8. A piece of inſpiſſated *ſuccus heliotropii*, commonly called *litmuſs*, or ſome linen rags, tinged by being rubbed with the red part of long radiſhes.

The water employed in the various experiments muſt be diſtilled, and alſo quite pure; becauſe it would be impoſſible to make any eſtimate with certainty of the conſtituent parts of the ſubſtances under examination, if a water were uſed impregnated with any other particles.

The operator muſt always be careful to avoid the fumes ariſing from ſubſtances which are brought into the fire; and therefore either have a chimney that draws well, or, when operating in the open air, ſtand in ſuch a manner that the wind may carry off the noxious fumes.

I ſuppoſe the pureſt parts of the ſubſtances required to be examined will be employed, and care uſed to take ſuch as are homogeneous, or nearly, as they will be beſt ſuited for the experiments, and to aſcertain the quality of a ſubſtance under examination.

I have often given more than one experiment on the ſame ſubſtance: This was done, when I either thought the one character reſulting from the one experiment not ſufficient to aſcertain the ſubſtance under examination, or when more ſubſtances under the ſame circumſtances would have the ſame phenomena. It will therefore be right to take as many proofs as poſſible, before you claſs or range a ſubſtance under a certain genus. Sometimes, however, I have given ſeveral methods of aſſaying the ſame ſubſtances; that, in default of one or other material neceſſary for the experiment, the operator might have an opportunity of diſcovering the contents of an unknown ſubſtance in a third way.

SECTION II.

On Mineral Subſtances in general.

EXPERIMENT I.

1. POUR diſtilled water on the mineral ſubſtance you want to examine; if it diſſolves the ſame, or part of it, either cold, or infuſed with warm or hot water, and put in a veſſel in ſand near a fire, for digeſtion; or by boiling it; and if the water by this means becomes impregnated with particles affecting the tongue with a ſharp or pungent ſenſation, the mineral ſubſtance thus examined is of a *ſaline* nature, or a kind of SALT.
2. It muſt be obſerved, that the greater part of pure ſaline ſubſtances diſſolve readily in water, except ſelenites and arſenic (which diſſolve only by boiling), and ſuch ſubſtances which are commonly called *ores*; and which likewiſe yield their ſaline particles when infuſed in water, after ſome other previous operations afterwards to be mentioned. The mineral ſubſtances intended for examination, ought to be pounded.
3. Saline ſubſtances will moſt commonly melt when put on the fire, and ſome of them crackle; others, on the contrary, will cauſe during fuſion an ebullition and froth. Fumes ariſe from them all during the operation.

EXPE-

EXPERIMENT II.

4. Mineral ſubſtances that will not diſſolve in diſtilled water, either entirely or partly, as in Experiment I. may be boiled in oil of olives or linſeed; and if they diſſolve therein, entirely or partly, they are of a *bituminous* nature, or BITUMENS or MINERAL INFLAMMABLES.

5. To aſcertain farther the experiment, the ſubſtances ought to be thrown on live coals; and if they burn there without any addition, and affect the ſmell during the operation, either with agreeable balſamic or often diſagreeable effluvia, the inference is eaſily made, that they are *bituminous*.

EXPERIMENT III.

6. Mineral ſubſtances which, when brought into the fire, will at laſt yield, after a violent degree of heat *, by eliquation, a ſhining, ſomewhat more or leſs ductile, ponderous ſubſtance, which may be decompounded in a long-continued fire, or by the addition of an acid; and may again, by adding an inflammable, be reſtored to its

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* Though it is not eaſy to give that degree of heat, without ſome chemical apparatus, which will be ſufficient to melt the metals out of their reſpective ores, I however found it neceſſary to give this Experiment, as it will be requiſite, to get an idea of the characteriſtic of metals.—The characters, therefore, given, No. 8, of metallic ſubſtances, though not ſo ſcientific and perfect as I could wiſh, will however be ſufficient to claſs the mineral bodies by. It is impoſſible to give ſuch general and exact characters of the claſſes, that a perſon ſhould never be at a loſs in determining what the ſubſtances under examination really are. It is enough to have pointed out a method by which he may as nearly as poſſible determine and claſs the ſubſtances; and there will be but few inſtances where the application of the rules here preſcribed will not be ſufficient.

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former ſtate by fuſion, are *metallic*, or METALS, taken in a general ſenſe.

7. Thoſe mineral ſubſtances, which, under the above circumſtances, will keep their original texture in the fire, in oil, or water, are of a *terreous* principle; which, when friable, and mixing with water into a kind of paſte, are EARTHS; if more ſolid or indurated, they are STONES.

8. It muſt be obſerved, in general, that metallic ſubſtances are commonly very ponderous, ſhining, ſometimes of a very regular ſtructure, and of very bright colours.

9. All mineral ſubſtances, therefore, may be reduced, according to the above experiments, to the following claſſes; I. EARTH, which contains both earths and ſtones; II. SALTS; III. INFLAMMABLES; and, IV. METALS.

10. Stony or earthy bodies, mixed with ſaline, or inflammable, or metallic particles, are called ORES: ſometimes the ſtony or earthy bodies are mixed with one, ſometimes with two of theſe ſubſtances, ſometimes with all. In theſe caſes, the rule takes place, *a potiori fit denominatio (i. e.* you muſt call it after the moſt prevailing ſubſtance); which muſt be underſtood both of the greater quantity, and of the value of the predominant ſubſtance.

SECTION III.

On Earthy and Stony Subſtances.

EXPERIMENT IV.

11. IF a few drops of a mineral acid, viz. the vitriolic, nitrous, or muriatic, be poured on an earth or ſtone, and the acid begins to diſ-

ſolve it with an ebullition, it is a *calcareous* ſubſtance.

12. The ſame inference is to be made, if a ſmall quantity of an earth or ſtone is thrown into an acid, and it is therein diſſolved with ebullition.

13. Sometimes ſtrong vinegar or alegar will ſerve the ſame purpoſe as the mineral acids, in diſſolving calcareous earths and ſtones. It muſt be likewiſe obſerved, that the ſtrongeſt mineral acids are not always the moſt efficacious for making ſolutions with; often a diluted acid operates better than a very concentrated one. However, it is better to carry the moſt concentrated ones, becauſe it is eaſy to weaken them, by the addition of water.

14. Beſides the above method of aſſaying calcareous ſubſtances, there is another, by putting a ſmall part of the ſubſtance ſuſpected to be calcareous, on a red-hot ſhovel over the fire; becauſe, if it be really calcareous, it is thus calcined into *quick-lime*, crumbles, and becomes in time friable, and, by the addition of water, raiſes heat and ebullition, and laſtly becomes *ſlacked lime*. A ſolution of quicklime in water is called *limewater*, and increaſes greatly the cauſticity of a ſolution of alcaline ſalt, or ſalt of tartar, when added to it. When this mixture is evaporated, the remainder is the *lapis cauſticus*, uſed by ſurgeons.

15. Some calcareous ſubſtances are united either with an acid or with an inflammable, or with an inflammable and acid at the ſame time, or with metallic parts, and will in ſuch caſes not effervesce with acids; but they may be found out in the following manner.

a. If the calcareous ſubſtance be mixed with acids, you need only put ſome of it on a ſhovel over the fire; if thus heated it will become friable, and with water unite into a ſolid maſs, commonly called *plaſter of Paris*, it is of a *gypſeous* nature, or *gypſum*. All gypſeous ſubſtances will by continued boiling be diſſolved, at leaſt for a time, in water,

b. If the calcareous ſubſtance be mixed with inflammable particles only, or inflammable and acid ones together, they may be diſcovered by rubbing the ſtone; which, in the firſt caſe, emits a moſt nauſeous ſtench, ſomewhat related to cat's piſs, and is then called *ſtink-ſtone*; or, in the latter caſe, it ſmells like putrid eggs, and is then a HEPAR SULPHURIS or LIVER-STONE.

c. If the calcareous ſubſtances be mixed with metallic parts, they are commonly very ponderous, and in many caſes of a more or leſs bright colour. Chiefly iron, copper and lead are mixed with calcareous ſubſtances. The firſt is commonly yellow, or ochraceous, orange, red, brown, black and ſometimes white. The ſecond metal tinges the calcareous ſubſtance, either fine blue or green. The laſt mixture is either white or pale-yellow, and ſometimes, though rarely, red or green.

16. Though there are a good many clayey or argillaceous parts mixed with calcareous ſubſtances, in MARLES, they efferveſce however with acids, and will crumble in pieces by being expoſed for ſome time to the open air, even though quite hard, and of a ſtony nature, when coming from under ground, or diſengaged from their ſtrata.

EXPERIMENT V.

17. If a ſtony or earthy ſubſtance cannot be ranged among the calcareous ones, according to Experiment IV. it may be pounded, infuſed with any of the acids, and then ſet in ſand near a fire, for digeſtion. If then all the ſubſtance, or the greater part of it diſſolves, and, by the gradual addition of a ſolution of ſalt of tartar, yields a kind of precipitate, which after repeated waſhings proves to be a real MAGNESIA *, or an abſorbent earth, which with acid of vitriol forms the true *Epſom-ſalt*, the ſubſtance thus examined belongs to the claſs wherein the amiant, the aſbeſt, the talc, and the various kinds of pott, bacon, ſerpentine, and hip-or nephritic-ſtone ought to be ranged, and may be called *atectous* ſtones †.

EXPERIMENT VI.

18. Take ſuch ſtony and earthy ſubſtances as, by the foregoing Experiments, IV. and V. prove to be neither calcareous nor atectous, (*i. e.* with a baſis of magneſia), pound the ſtony ones, and ſuch as are earthy waſh carefully, and ſeparate thus from them all the ſtones, grit, or ſand, and then infuſe the dried earth or pounded ſtone with acid of vitriol. If part of it, or the whole diſſolves, and, after a few drops of a ſolution of ſalt of tartar are put into it, the ſolution, being decanted and evaporated, will

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* See Dr. Black's Paper on the *Magneſia*, in the Philoſophical and Literary Eſſays, publiſhed at Edinburgh, vol. II.

† For the curious experiments on the abovementioned ſubſtances, ſee *Margraff's Oeuvres Chymiques*, vol. II.

yield *alum* *, then the ſubſtance is of a *clayey* or *argillaceous* nature.

19. All argillaceous earths and ſtones grow harder, when put into the fire; ſome of them attain therein that degree of hardneſs, that, when ſtruck with ſteel, they will ſtrike fire.

EXPERIMENT VII.

20. If the ſtones which are neither calcareous, atectous (*i. e.* with a baſis of magneſia) or argillaceous, be brought into the fire by themſelves, without any additional ſubſtance, and they fly in ſmall pieces, with a crackling noiſe, then they are FLUORES, or FUSIBLE SPARS.

21. This kind of ſpar, or fluor, has lately been found, by the experiments of *Mr. Scheele* †, to conſiſt of a common calcareous earth, and an acid *ſui generis*, or *acid of fluor*; which has leſs affinity to the calcareous earth than any of the three common mineral acids; for if on the pounded fluor any of the acids be poured, and the whole be brought into the fire for diſtillation, an acid goes over which has peculiar properties, and eſpecially that of forming a *quartz*, with ſteam of water.

EXPERIMENT VIII.

22. Take a ſteel, and ſtrike with it any of the ſtones which could not be ranged by the Experiments IV.—VII. If they ſtrike fire with ſteel, and will mark glaſs, they are of a *flinty nature*.

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* For the properties and character of *Alum* ſee hereafter, Sect. IV. Exper. XXI.

† The Memoirs of the Academy of Sciences at Stockholm, for the Year 1771.

23. Some ſtones of this claſs are of a regular angular form, fine tranſparency, brightneſs of colours, and ſuperior hardneſs, and are then called *gems*. The diamonds, which, on account of their bright radiant ſplendor and immenſe hardneſs, (that will yield to no file, tool, or ſubſtance whatſoever, except diamond-powder), are the firſt in this genus of ſtones, will, however, in a long-continued violent fire, firſt grow opaque, then lamellated, and laſtly ſo volatile as entirely to fly off *. The ruby is next in rank in point of hardneſs, but is unalterable in regard to ſize, colour, and texture. The reſt are all ſofter; ſome will even be attacked by a file (viz. the emerald, chryſolite, amethyſt, hyacinth, berill, and garnet), and ſome loſe colour and texture in a violent fire.

24. *Quartz*, one of the flinty ſtones, is, according to the experiments mentioned No. 21, a compound of the acid of fluor and ſteams of water meeting together. This circumſtance makes it highly probable, that diamonds are likewiſe formed by the moſt ſubtle ſteam of water and of acid of fluor, becauſe they are ſo volatile in a violent long-continued fire.

25. Stones of a lamellated, gloſſy texture, whoſe lamellæ are commonly pliable, which, according to experiments IV.—VIII. are not acted upon by acids or fire, except that its lamellæ loſe their flexibility, and ſhiver into thinner

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* The experiments of the late emperor Francis are mentioned in *Henckel's Oeuvres*, Paris, 1760, 4to. vol. II. p. 413. note; and thoſe of Mr. Darcet, on Diamonds, are found in his *Memoire ſur un feu violent & continué pendant un long tems*; and in his *Memoire ſecond*.

leaves, muſt be called *micaceous* ſtones, or *micæ*; *daze*, or *gliſt*, in Engliſh.

26. There are a great many ſtones, which, at the very firſt appearance, are *compounded* ones. It is impoſſible to deviſe a ſhort and eaſy method for aſſaying them in this general and ſummary way. Stones and earths which are homogeneous, or nearly ſo, are beſt ſuited for experiments. Thoſe that are confeſſedly compoſed of particles of one, two, three, and more earthy or ſtony ſubſtances, if their particles be flinty only and ſmall, they are *ſand-ſtone*; if calcareous, and compoſed of round grains, they are *ſpawn-ſtone*; if large, and of a flinty nature, glued as it were together, they are *pudding-ſtones*; if the integrant parts be of more than one kind, they are *rock-ſtones (karn*, or *moor-ſtones)*; to which kind the *granites* and *porphyries* likewiſe belong, being really of the ſame nature, only of a finer texture.

27. If the earths or ſtones have a configuration bearing a great ſimilarity to ſome of the animal or vegetable ſubſtances, they are *petrefactions*; which may be divided into *real petrefactions*, into *incruſtations*, into *impreſſions*, and *luſus naturæ*; according as the animal or vegetable ſubſtance is either really changed into ſtone; or has been only covered or coated with a layer of ſtony ſubſtance; or has only made an impreſſion on the ſtony ſubſtance before its induration; or if the ſtone has only an accidental ſimilarity with an animal or vegetable, or parts thereof.

SECTION IV.

On Saline Subſtances.

28. SALINE ſubſtances, or *ſalts*, are either of a ſour taſte and corroſive quality, in a fluid form commonly, when pure, and then they are called ACIDS; or they have an acrid, fiery and ſomething ſweetiſh taſte, and then they are called ALKALIS OF ALKALINES.

29. *Acids* are not to be met with in the whole extent of nature in their pure ſtate, unleſs in ſome mineral vapours; and even then they are allied either to water, inflammables, or ſome other volatile principles. Acids, mixed with earthy, bituminous, alkaline, and metallic particles, are frequently obvious, and from theſe mixed ſubſtances they may be extracted in their purity; that is to ſay, as far as poſſible; for appearing conſtantly in a fluid form, they are blended more or leſs with aqueous particles.

EXPERIMENT IX.

30. TAKE ſyrup or tincture of violets, and put in it a few drops of any fluid you ſuſpect to be a mineral acid; and it will turn the ſyrup or tincture of violets red, if it really be an acid.

31. The tincture of *litmus*, or *ſuccus heliotropii*, or *turneſol*, has the ſame property in trying acids. But it is ſtill better to take common radiſhes, and rub with the fine purple on the upper part of their roots ſome linen rags, ſo that they may be thus tinged purple. If a drop of any acid whatſoever falls on the purple ſpot, it turns inſtantly red, and

brightens it very much. As the ſyrup of violets is apt to ferment in hot countries, it is better to take a piece of the inſpiſſated *ſuccus heliotropii (i. e. turneſol)*, or ſome of the abovementioned linen rags tinged with radiſhes, and to employ them on a voyage or journey; becauſe it is very eaſy to make a tincture of *turneſol*, or *lacmuſs*, with water.

32. It muſt however be obſerved, that a volatile ſulphureous acid deſtroys the colours, and that a ſolution of alum will ſometimes produce the ſame effects which acids will, in changing blue and purple made of vegetables into red.

EXPERIMENT X.

33. If you have an alkaline ſalt, which you know to be ſuch (for inſtance, ſalt of tartar, or ſpirit of hartſhorn), and you want to examine ſome fluid, in order to aſcertain whether it be an acid, put ſome ſolution of one of the alkaline ſalts into it, and it will cauſe an efferveſcence, if the fluid be an acid; and if you continue to put gradually ſo much of an alkaline ſolution to it, till the ebullition, heat, and vapours ſubſide, you have *ſaturated* or *neutralized* the liquors; or it may be ſaid you have brought the fluids to the *point of ſaturation*; and after the ſuperfluous water is evaporated, the neutralized ſalt will ſhoot into regular figures, or *cryſtallize*, and then become a *neutral* or *ſaline ſalt*.

EXPERIMENT XI.

34. If the ſyrup or tincture of violets, or cyanus, or the tincture of litmuſs, or the purple-coloured rags, mentioned in Experiment IX.

turn green from the addition of a ſolution of ſome unknown ſaline ſubſtance, it muſt be an ALKALI.

35. It ought to be obſerved, that a ſolution of alum will ſometimes turn the ſyrup of violets green; but the ſtyptic adſtringent taſte of that ſolution, ſo widely different from that acrid fiery taſte peculiar to alkalines, would be ſufficient to aſcertain them.

36. The urinous volatile ſmell, known from that of ſpirit of hartſhorn, is more than ſufficient to diſtinguiſh the fixed alkalies from the volatile.

EXPERIMENT XII.

37. POUR ſome one of the acids on the ſaline ſubſtance you want to try: If theſe ſaline liquors efferveſce together, and cryſtallize after evaporation into a body of a regular angulated figure, the ſubſtance thus mixed with the acid muſt be an *alkaline ſalt*.

38. The various compounds of acids, and other mineral ſubſtances, have cauſed ſuch various mixtures in nature, that it would be difficult to aſcertain them with any degree of certainty in this ſummary method; it is therefore ſufficient to point out only the way of aſſaying thoſe which are moſt obvious and moſt uſeful.

EXPERIMENT XIII.

39. IF an ore be ſuſpected to contain ſome ſaline ſubſtance, pound it, and put it in a new unglazed pot, on the fire, calcine, and ſtir it during the calcination with a wire, or the tube of a tobacco-pipe, till it ceaſes to ſmoke, and till all the ſulphureous or arſenical parts are evapo-

rated by fumes. Then pour a ſufficient quantity of diſtilled water on it; and after it has diſſolved all the ſaline particles of the infuſed ſubſtance, decant it into a flat glaſs, cover it, and put it on a warm place for evaporation, till it forms cryſtals, which may be kept for the following experiments.

40. Care muſt be taken not to employ any copper, braſs, or iron veſſels, to diſſolve, boil, or evaporate ſalts in; becauſe their acids often unite readily with the particles of the veſſel, and thus ſpoil the experiment. Lead may be employed; but glaſs, porcelain, or glazed earthen veſſels, are the beſt in ſmall aſſays.

41. A great many ſaline ſubſtances may be judged to be ſuch, by bare inſpection and by taſting them; and as they do not want any previous calcination, becauſe they are not united with ſulphureous or arſenical particles, they may be immediately employed for the Experiments hereafter to be mentioned. Some which are leſs pure may be diſſolved in water, ſtrained through blotting-paper, and then evaporated till cryſtallization enſues. If the ſaline particles will not readily diſſolve in cold water, hot or boiling water will ſometimes do it.

EXPERIMENT XIV.

42. If the cryſtallized ſalts extracted from an ore, according to Experiment XIII. have a ſtyptic, adſtringent taſte, and be either white, roſe-coloured, green, or blue, and their ſolution will ſtrike an infuſion of tea or galls purple-coloured or black, it is evident that they are *vitriolic metallic ſalts*. In the firſt

and ſecond caſe, they contain zinc and vitriolic acid; in the third, they are compoſed of iron and vitriolic acid; and in the laſt caſe, copper and the above-mentioned acid are its integrant parts; and the firſt and ſecond is VITRIOL of ZINC, the third that of IRON, and the laſt that of COPPER.

43. There are but few inſtances of a metal being found naturally united with any other acid than the vitriolic; and therefore it may be concluded, with a pretty good degree of certainty, that ſuch metallic *ſalts* which have the above qualities are *vitriolic.*

44. There are inſtances that the vitriolic metallic ſalts contain more than one metal for their baſis; and in ſuch a caſe, the colours of the ſalts are of a hue intermediate between the original colour of the ſalt, when it contains but one metal.

EXPERIMENT XV.

45. IF a ſalt found in its pure and native ſtate, or its ore, be thrown on live coals, or a red-hot plate of copper, and its fumes have a ſmell like garlick, and a white ſpot remains on the copper-plate, or the fumes caught upon a copper-plate look like a white powder, it is certain that the ſalt or ore thus examined is ARSENIC.

EXPERIMENT XVI.

46. IF you put into a ſolution ſuſpected to contain *Glauber's ſalt*, or *ſal mirabile*, ſome ſpirit of wine, a white powder will be precipitated, in caſe it really contains GLAUBER'S SALT.

EXPERIMENT XVII.

47. If a ſaline ſolution be mixed with a ſolution of lime in the nitrous acid, and it precipitates a *ſelenite*, the ſalt of the examined ſaline ſolution is a SAL MIRABILE, or GLAUBER'S SALT; and the remaining liquor, after it has been ſeparated from the precipitated ſelenite, may be decanted, evaporated, and cryſtallized; and the produced ſalt will be the *nitrum cubicum*, or quadrangular nitre, which is remarkable on account of its cubic cryſtals.

48. The *ſal mirabile* has, beſides the above-mentioned properties, that of forming rhomboidal truncated cryſtals; which in a moderate degree of heat grow opaque, and crumble in pieces. In a more intenſe degree, the ſalt melts; and in very great and violent fire it pierces the crucible. Its taſte is bitter.

EXPERIMENT XVIII.

49. If a ſaline ſubſtance forms hexagonal priſmatic cryſtals, which when thrown into the fire will burn fiercely with a white flame, and when put in an open veſſel into a moderate heat will melt, and when again cooled congeal into a ſolid, ſonorous, ſemitranſparent maſs, it is NITRE or SALTPETRE.

50. Saltpetre is commonly obtained from a ſoil impregnated with urinous, and other animal parts, which unite with the univerſal acid by being expoſed to the open air for a long while. Therefore, a land richly manured, fields of battle, burying-places, the dirt of the ſtreets in great towns, &c. are uſefully employed for manufacturing ſaltpetre. The

nitrous acid particles are extracted by pouring a good quantity of hot water on it; and by the addition of a ſolution of potaſhes, or of a ſolution of ſalt of tartar, the nitre is obtained, after boiling or evaporating the mixed ſolutions. Native cryſtallized ſaltpetre has hitherto been found but in one place.

EXPERIMENT XIX.

51. If a ſaline ſolution forms cubic cryſtals, when thrown on the fire or live coals decrepitates, or cauſes a crackling noiſe, when brought in a veſſel into the fire will melt after it had been red-hot, and congeal into a quite opaque maſs, it is MURIATIC or COMMON SALT.

52. The taſte of common ſalt is ſo well known to the civilized part of the human ſpecies, that it is almoſt unneceſſary to give any other character, but refer the operator to the taſte. It is made of the brine of the ſea, of that of ſome wells and lakes, and often found ſolid in ſtrata, but rarely mixed with earth or ſtone; in which caſe it may be infuſed with hot water, and the infuſion decanted and evaporated till it forms cryſtals.

EXPERIMENT XX.

53. Take fine ſilver, diſſolve it in nitrous acid, by throwing in thin ſmall particles at a time; in this ſolution of ſilver drop a few drops of a ſolution of *ſalt*, ſuſpected to be *common* or *muriatic*; for in this caſe it will immediately become turbid, and form a precipitate, like curd; which after being ſeparated from the ſupernatant liquor, dried and put into the fire in a glaſs or earthen-ware veſſel, will melt, and form a ſub-

ſtance reſembling horn, for which reaſon it is called *horn-ſilver*, or *luna cornua*.

EXPERIMENT XXI.

54. If a ſaline ſubſtance forms featherlike cryſtals, has a fiery, urinous taſte, melts in a moderate fire, and becomes volatile in an increaſed heat, and when pounded and mixed with quick-lime will yield an urinous volatile ſpirit, it is certainly SAL-AMMONIAC.

EXPERIMENT XXII.

55. If a ſaline ſubſtance has at firſt a ſweetiſh, but afterwards a cauſtic bitter taſte, ſwells and froths in the fire, but by length of time melts into a tranſparent glaſs, if its ſolution ſtrikes the ſyrup of violets green, and by adding one of the acids to its ſolution, it will form by evaporation and cryſtallization firſt a new neutral ſalt, called SEDATIVE SALT, and laſtly the remainder will form a neutral ſalt, compounded of the acid employed and the mineral fixed alkali, which is the baſis of this ſaline ſubſtance; if all this happens it muſt be BORAX.

56. Borax precipitates all the metallic ſolutions, and alſo the ſolution of alum. It is brought in its crude ſtate from Perſia, and the Eaſt-Indies, and then called *tincal*; and may be refined into borax, by pouring hot water on the tincal, decanting the liquor and evaporating it gradually.

EXPERIMENT XXIII.

57. If a ſaline ſubſtance has a ſtyptic taſte, ſwells and froths in the fire, or when put on a red-hot ſhovel over the fire, crumbling after this

operation into a white powder, and if its ſolution ſtrikes the tincture of violets green, it is ALUM.

EXPERIMENT XXIV.

58. If a ſaline ſubſtance has a bitter taſte, you may put into its ſolution a ſolution of any alkali whatſoever, which will turn the ſame firſt milky, then curdly, and at laſt precipitate a white earth, which is a proof of its containing an EPSOM-SALT, compounded of acid of vitriol and magneſia.

SECTION V.

On Inflammable Subſtances.

EXPERIMENT XXV.

59. IF a mineral inflammable ſubſtance be found quite tranſparent, liquid, of no colour, of a fragrant ſmell, extremely volatile and inflammable, and attracting gold from its ſolution in *aqua regis*, it is called NAPHTHA.

EXPERIMENT XXVI.

60. IF a liquid inflammable ſubſtance be found coloured yellow, brown, or even black, has a fragrant ſmell, but will not take fire at a diſtance, nor attract gold from its ſolution in *aqua regis*, it muſt be PETROLEUM.

EXPERIMENT XXVII.

61. IF an inflammable be only ſomewhat liquid, like tar, and has a diſagreeable ſmell, it is MOUNTAIN-TAR.

EXPERIMENT XXVIII.

62. If a mineral ſolid inflammable has a yellow or reddiſh colour, is brittle, bears turning and poliſhing, yields when burnt a fragrant ſmell, and when rubbed will attract light bodies, it is YELLOW AMBER.

63. The colour of amber varies ſo much, that even pieces of white or black are not uncommon, and blue or green ones have been found, though rarely. It is commonly tranſparent, or ſemiopaque, ſeldom quite opaque.

EXPERIMENT XXIX.

64. If a ſolid grey inflammable has no taſte, a fragrant ſmell, is friable, when pounded ſticks to the mortar, when pierced with a hot needle will not ſtick to it, when burnt on a hot iron ſhovel yields but little ſmoke and leaves very little aſhes, it is AMBERGREASE.

EXPERIMENT XXX.

65. If a ſolid inflammable is black, gloſſy, and yields when burnt a ſuffocating ſulphureous ſmell, leaving a good deal of clayey or argillacous earth or aſhes behind, it is PIT-COAL.

66. *Pit-coal* differs from *jet* and *mountain-pitch*, or aſphalt, only in the degree of hardneſs, ſolidity of texture, and ſpecific gravity.

EXPERIMENT XXXI.

67. If an inflammable ſubſtance, when put on live coals, ſends forth denſe ſuffocating fumes, burns with a blue flame, and has the known brimſtone ſmell, it is SULPHUR, or contains at leaſt ſulphureous particles.

68. There are ſometimes found native ſulphurs, which are tranſparent like yellow amber, and have fine bright colours; others, in the form of ores, are very gloſſy, and of regular angulated figures, and have a gloſs like a real burniſhed metal; but they ſoon betray their ſulphureous particles, by the ſuffocating fumes they yield, when put on a red-hot ſhovel.

SECTION VI.

On Metallic Subſtances.

69. IN regard to metallic ſubſtances, it muſt be obſerved, that when they are pure and unmixed, it is not a very difficult matter to find the quality of the metal; but in caſe they are mixed, and the nobler metals, for inſtance, have ſome alloy of the baſer ones; or if the metallic ſubſtances are in the various ores mixed with ſulphureous, arſenical, and other particles, it is impoſſible to give inſtructions for finding their contents, without giving a full detail of the whole art of Aſſaying; which would go beyond our intended plan. We therefore content ourſelves with giving ſuch inſtructions as will enable every man, with moderate parts, and with no other apparatus than that which we recommended at the beginning of our paper, to aſcertain the metal contained in an ore.

70. We ſuppoſe the experiments will be made with ſmall portions of the ores or metals; ſo that, if at all, any waſte of them ſhould be made, the loſs may not be great.

EXPERIMENT XXXII.

70. If you can diſcern with the naked eye ſome ſpecks of gold in an ore, pound it minutely, and put it in a wooden or glaſs or glazed earthen veſſel; take four parts of mercury to one of the ſuppoſed gold ore; pour it on the powder, rub it carefully with a wooden or glaſs peſtle, and when the mercury has been perfectly united with all the particles of gold, the maſs (called an *amalgama)* muſt be ſqueezed through ſhamoy leather; and then put in a glaſs or porcelain veſſel for evaporation on the fire, when the mercury will fly off and leave the gold behind. After the gold is thus extracted, it may be eaſily melted with the addition of ſaltpetre and borax, and then it may be tried with aqua regis, which diſſolves gold, but not ſilver.

72. If the quantity of gold amalgamated with quickſilver is very ſmall, and ſcarce worth melting, it is better to take a bright piece of copper, braſs, or ſilver; waſh it with weak aquafortis, or much-diluted ſpirit of nitre; put on the waſhed metal or ſilver ſome of the amalgama, till it is every where uniformly covered, and then put it on live coals; but ſo that it may not come in contact with the coals. The mercury will thus evaporate, and leave the ſilver, or metal gilt; which muſt, however, yet be cleaned by boiling and waſhing in water, with common ſalt and tartar, to give it brightneſs.

EXPERIMENT XXXIII.

73. If you ſee ſome native ſilver in an ore, ſeparate it carefully from the ſtone or ore, and try to diſſolve it in aquafortis or ſpirit of nitre, wherein it will diſſolve moſt readily, if it be

ſufficiently thin and ſmall, and not too much of it put at one time into the aquafortis. Into the ſolution put a few drops of a ſolution of common ſalt, and it will ſoon become turbid, and precipitate a curdly ſubſtance. See Experiment XX. numb. 54.

EXPERIMENT XXXIV.

74. If you intend to aſſay any ore whatſoever, pound it firſt minutely, calcine it on the fire in an earthen veſſel, conſtantly ſtirring the ore with an iron wire or tobacco-pipe-tube, till the whole entirely ceaſes emitting any fumes.

EXPERIMENT XXXV.

75. Pound an ore ſuſpected to contain tin, make a ſhovel red-hot; extend the pounded ore on the ſhovel; the leſs the particles of ore crackle or fly, the more it contains tin; eſpecially if it becomes by this operation of a greyiſh red colour, and covered with a white arſenical effloreſcence. Continue to calcine the ore ſtrongly, ſeparate the iron which might be ſtill contained in it by a loadſtone, infuſe it with aqua regis, putting gradually but ſmall bits in the aqua regis, till it be ſufficiently impregnated, and decant it. Take a ſolution of gold in aqua regis, let one or two drops of it fall into the ſolution of the ſuſpected tin-ore; if it becomes purple, it is certainly TIN.

EXPERIMENT XXXVI.

76. If you add to the calcined ore you intend to examine ſome pounded charcoal, and ſet it in an earthen veſſel on a good fire in a forge; if it melts eaſily, and the metal thus obtained be diſſolved in vinegar, and a few drops of *liquor*

vini probatorius be put in it, and it turns immediately black, it muſt be LEAD.

77. The ores of lead are commonly gloſſy, conſiſting of cubical parts, which are of different ſizes, according as they contain more or leſs of ſulphur; thoſe which have large cubes melt very eaſy. Thoſe lead-ores which are formed by a calx of lead will melt, after being calcined and ſtratified as above with charcoal, and ſome addition of ſaltpetre and tartar.

EXPERIMENT XXXVII.

78. TAKE the calcined ore, add ſome butter, ſuet, train-oil, or other animal fat ſubſtance; calcine it thus a ſecond time, ſtirring it continually; then try whether the magnet or *loadſtone* will attract ſome particles of it; in which caſe it is IRON.

79. Or pour on the calcined ore vitriolic acid, let it digeſt in a warm place; if a nauſeous ſmell enſue, with a kind of efferveſcence, and the whole infuſion grow dark-brown or reddiſh, or if this ſolution will ſtrike an infuſion of gallapples or tea black, it is IRON.

80. Or take equal quantities of dry ox-blood and ſalt of tartar, burn the pounded and mixed ſubſtances in a crucible, diſſolve the aſhes in a ſufficient quantity of water; pour ſomewhat of this liquor in a diluted ſolution of an ore ſuſpected to contain iron; if the watery or diluted ſolution turns blue, and precipitates a blue powder, the ore thus examined contains IRON.

EXPERIMENT XXXVIII.

81. **Infuse** in a glaſs the calcined ore, with a ſolution of potaſhes or ſalt of tartar, mixed together with that of quicklime, and let it ſtand in a moderately warm place; if the ore becomes on its outſide covered with a fine ſky-blue colour, it undoubtedly contains COPPER.

82. Infuſe the calcined and pounded ore with acid of nitre, put it in a temperate place for digeſtion, dilute the ſolution in a great deal of water, and gradually add ſome *ſpirits of hartſhorn*, or *volatile alkali*; if this ſtrikes the diluted ſolution blue, the ore will yield COPPER.

EXPERIMENT XXXIX.

83. **Infuse** the calcined ore with vitriolic acid, dilute the ſolution with water; if it precipitate a white powder, and afterwards yield by evaporation and cryſtallization red cryſtals, the ore contains COBALT.

84. Wiſmuth and Cobalt are commonly joined in their ores; the firſt native, the ſecond mineralized with arſenic and ſulphur. The calcination expels the ſulphur and the arſenic, both being volatile; the calxes of wiſmuth and cobalt remain in the earthy or ſtony remnant. The vitriolic acid diſſolves both; but if the ſolution be diluted with water, the calx of wiſmuth is precipitated; and the reſt, being evaporated, yields the *vitriolum cobalti*, which has red cryſtals. Thus wiſmuth and cobalt-ores may be tried both at once.

EXPERIMENT XL.

85. If an ore before its calcination has a fibrous, ſtriated texture, it is probably an *antimonial* one; it therefore may be put into a pot with a ſmall hole at its bottom, fixed into another pot or crucible, without touching its bottom, and then ſet it into a forge; when it will yield with eaſe in the lower pot CRUDE ANTIMONY.

EXPERIMENT XLI.

86. If a ſtrongly-calcined ore be infuſed with acid of vitriol, and the ſolution after evaporation and cryſtallization will yield white or roſe-coloured cryſtals, it is ZINC or CALAMINE.

EXPERIMENT XLII.

87. If an ore before calcination be very ponderous, has a dark-red or black and red colour, and a ſtriated fibrous texture, it is probably a *mercurial* ore; and it may be eaſily aſcertained by the following method: Take a clear earthen ſmall pot, fit into its mouth, as exactly as poſſible, a flat piece of iron, pierced with a quantity of ſmall holes; pour ſome water into the pot, about two inches high; then take the ore, put it on the iron plate; take another pot, exactly fitting within the mouth of the former, lute all the holes, eſpecially round the joining of the two pots, carefully, Bury the firſt or lower-moſt pot in aſhes, or ſoil, and cover it round with ſtones; then make a good fire round the uppermoſt pot, till it becomes red-hot; keep it thus for about half an hour; after which operation, the QUICKSILVER muſt needs be in the lower veſſel, covered with water.

A
SERIES OF EXPERIMENTS
BY WHICH THE
INTEGRANT PARTS
OF THE
FLUOR SPATOSUS,
OR,
SPARRY FLUOR,

[P. 109, of Cronſtedt's Mineralogy]

ARE DISCOVERED.

BY

CHARLES WILLIAM SCHEELE.

ABSTRACTED FROM THE
Memoirs of the ROYAL SWEDISH ACADEMY of
SCIENCES for the Year 1771.

A
SERIES OF EXPERIMENTS
ON THE
SPARRY FLUOR.

SECTION I.

Experiments on the Sparry Fluor.

1. THE Sparry Fluor, or Fluor Spatoſus of CRONSTEDT's *Mineralogy*, is called by WALLERIUS *Glaſs-Spar*, or *Spatum ſolidum plus minus pellucidum, particulis non diſtinguibilibus.* WOLTERSDORF, in his *Syſtema Minerale*, gives it the name of *Spatum Vitreſcens*, and deſcribes it in the following manner: *Lapis figura & colore varius, fragmentis rhomboidalibus diaphanis reliqua ſpati genera duritie antecedens.* In FORSTER's *Mineralogy* it is called *Vitreſcent Spar (Spatum Vitreſcens)*; and the great Dr. LINNÆUS mentions it in his 12th edition of his *Syſtema Naturæ*, by the name of *Muria Chryſolampis*; and deſcribes it, *Muria lapidoſa ſubquartzoſa aggregata ſparſa fixa.* The Experiments of Mr. SCHEELE were chiefly made upon a green ſort of this *Sparry Fluor*, from *Garpenberg*, in the province of *Dalerne*; and upon a white kind, from Giſlôf, in the province of *Scania*.

This kind of Sparry Fluor, upon being made red-hot, loſes the property it is commonly poſſeſſed of, to ſhine, or to have a phoſphoreſcence in the dark when it is but gently warmed. This quality of appearing luminous when moderately warmed, is, according to Dr. Linnæus, peculiar to all the Sparry Fluors of whatſoever colour.

2. This ſpar, when put in a crucible on the fire, crackles or decrepitates like common ſalt, and flies; afterwards it becomes friable, white, opaque, and the green kind turns red.

3. If this ſpar be gently warmed, and put into water, it ſhines therein as well as in the open air, though not with an equal degree of brightneſs. If put into acids, after being moderately warmed, it ſhines even there. But a ſolution of ſpar does not phoſphoreſce when warmed.

4. Spar that has once loſt its phoſporeſcence by being made red-hot, will not recover this quality, though it be ſtratified with charcoal, and thus calcined, or though it be expoſed to the heat of the ſun. By this experiment it becomes evident that this ſhining quality of the Sparry Fluor is not cauſed by any inflammable principle; and we may likewiſe from thence make this inference, that this ſpar is widely different from the *Bononian ſtone*, all gypſums, alabaſters, and ſelenites, which will get a kind of phoſphoreſcence by being ſtratified with charcoal, and then calcined. See MARGGRAFF's *Opuſcules Chymiques*, vol. II.

5. Two ounces of this ſpar being infuſed with an equal quantity of oil of vitriol, and then diſtilled, firſt, very elaſtic vapours aroſe, but afterwards the fumes appeared white, and co-

vered the inner ſurface of the recipient. The maſs which was left in the retort after the operation was over, was almoſt as hard as ſtone.

6. The ſame phænomena appeared, when a quantity of water was put in the recipient. The vapours in their firſt riſing, formed a white ſpot on the ſurface of the water, which by degrees encreaſed to ſuch a thickneſs, as entirely to obſtruct the further acceſs of the vapours to the water. The veſſel being ſhook, this cruſt was broken into ſeveral pieces, and ſunk to the bottom. Immediately after, a new cruſt was formed by the contact of freſh vapours with the ſurface of the water. At the end of the operation, the inner ſurfaces of the retort and the recipient appeared white, and were conſiderably corroded. The water in the recipient, upon examination, contained a conſiderable quantity of a new acid, diſengaged from the ſpar by the oil of vitriol.

7. The maſs remaining in the retort (5) being pounded and edulcorated with water, the *lixivium* was inſpiſſated till a pellicle appeared on its ſurface; by the addition of two ſcruples of alum, a quantity of ſelenties was depoſited; the ſuperabundant acid was again ſaturated with ſalt of tartar, but there enſued no further cryſtallization.

8. The laſt inſpiſſated *lixivium* turned blue, by the addition of a *lixivium of ox-blood*, and this only when the green ſpar had been employed for the experiment, which proved that ſome particles of iron had cauſed the green colour in the *Sparry Fluor*.

9. The reſiduum which remained after the edulcoration (7) was boiled in ſeven gallons of rain-water, by which operation a conſiderable quan-

tity of it was diſſolved; the undiſſolved part proved to be a fourth of the original quantity. This undiſſolved reſiduum was pounded and calcined with oil of vitriol, till all the fluid was evaporated; and during the operation a quantity of elaſtic fumes were ſeparated. The maſs was eaſily diſſolved in water, having been previouſly cooled and pounded. By the addition of *ſpiritus ſalis ammoniaci cum calce* no precipitation was produced; but a calcareous earth was precipitated upon the addition of ſalt of tartar. The remaining fluid yielded a *tartarus vitriolatus*, becauſe the *ſal tartari* had decompounded the diſſolved *ſelenite*.

10. From the above experiment it appears, that the *Sparry Fluor* is a calcareous earth ſaturated with its own acid. The alum and iron ſeem to be ſubſtances, which are only accidental in the mixture of this mineral body. Diluted *acid of ſpar* (6), upon being mixed with lime-water, precipitated a white powder, which, though not in the form of cryſtals, yet had all the properties of the original ſpar: For when ſpread on a hot ſtone it became luminous; it melted by the blowing-pipe, eſpecially upon the addition of a ſmall quantity of gypſum; and laſtly, this new ſpar could again be decompounded in the ſame manner as the original ſubſtance, by the addition of oil of vitriol.

11. The white cruſt (6) formed on the ſurface of the water in the recipient, had the following properties:

a. It could not be diſſolved in any acid.

b. When pounded it would not form any paſte with water.

c. Upon being boiled with *oleum tartari per deliquium*, it was diſſolved; and when grown cold, it turned into a kind of gelatinous ſubſtance.

d. It was not acted upon by fire, when expoſed to its action by itſelf.

e. Upon the addition of an alkali, it melted into glaſs.

f. This glaſs, with three parts of a common fixed alkali, melted into a blue maſs.

g. The ſame being pounded, and put into a cellar, very ſoon ran *per deliquium*, and turned into a gelatinous ſubſtance.

h. An acid precipitated a powder from it.

i. It was diſſolved in borax, without the leaſt efferveſcence. All theſe circumſtances prove it to be a real *ſilex*, or *flinty* ſubſtance.

12. In a metallic cylinder a quantity of pounded Spar was put, and then infuſed with oil of vitriol. A wetted charcoal, or piece of iron, was ſuſpended in the middle of the cylinder, and all being covered and properly ſecured, was placed near the fire. In four hours, a white cruſt, ſimilar to the abovementioned (6), was formed round the coal and the iron. This experiment proves, that the abovementioned incruſtation was not formed from the corroſion of the glaſs, which is mentioned above (6), but rather from the aqueous particles uniting with the acid of Spar. What is more corroborating than all this is, that the *artificial* or *regenerated* Spar (10), upon being decompounded in the ſame manner with oil of vitriol, formed the very ſame kind of cruſt on the ſurface of the water in the recipient; but repeating the operation, with the ſame identical Spar, for ſeveral times, no cruſt was farther formed; becauſe the acid of Spar had been all expelled in the former operations. Nor can it

be ſaid, that the Spar had ſome flinty parts in its original compoſition; for the ſame thing happened when the natural and the artificial Spar was decompounded; and if there were any ſilex in its compoſition, it would have been precipitated upon the very firſt diſtillation; whereas we find it happened equally upon the experiment being repeated numbers of times. If *alcohol*, *common oil*, *i. e. oil of olives*, or *oil of vitriol*, were put into the recipient before the operation for decompounding the Sparry Fluor, no flinty cruſt was formed, which only happened when water was in the recipient. The acid of ſpar uniting with the *alcohol*, had no other effect than to give it an acid taſte.

13—15. Spirit of ſalt and that of nitre, employed inſtead of oil of vitriol, in the diſtillation of Spar, expelled from it the ſame acid, which formed likewiſe the ſame kind of cruſt (6) with the water in the recipient. It appears from this experiment, that as Becher and Stahl both pretend, that oil of vitriol contains a ſiliceous or flinty kind of earth, the ſilex formed here is by no means formed by the pretended ſiliceous particles of the oil of vitriol.

16. If Spar be diſſolved by heat in acid of nitre, or muriatic acid, and *ſpirit of ſal ammoniac* be added, a true calcareous earth is precipitated, which effervesces with all acids; but if *ſpiritus ſalis ammoniaci cum calce* be employed, a fine Spar is precipitated. The ſame thing happens from *ſalt of tartar*, or any fixed alkali, whether mild or cauſtic. If acid of vitriol be poured on the ſolution, a gypſum is precipitated, which likewiſe happens upon the addition of *ſal catharticum amarum*, *tartarus vitriolatus*, or *ſal Glauberi*.

17. Acid of phoſphorus ſeparates likewiſe the acid of Spar, and expels it by diſtillation. The reſiduum has all the properties of aſhes of bones; which have been lately found to conſiſt of the acid of phoſphorus and calcareous earth.

SECTION II.

Combinations of Spar with Alkali.

18. ONE part of this Sparry Fluor being mixed with four parts of cauſtic fixed alkali, the mixture eaſily melts when brought upon the fire, but no part of the Spar has thus been made ſoluble in water.

19. One part of this Spar being mixed with four parts of common fixed alkali, and then melted, a quantity of water was poured upon it, by which all whatever was ſoluble really was diſſolved, and nothing but a calcareous earth was left at the bottom of the veſſel, which effervesced with acids. The ſupernatant liquor, upon being evaporated, was found to be an alkali ſaturated with acid of Spar.

SECTION III.

Combinations of Spar with Salia Media.

20. ONE part of Spar being mixed with two parts of ſal ammoniac, and then diſtilled, a little of volatile alkali came at firſt over, afterwards the ſal ammoniac was ſublimated, and at laſt, ſome yellow ſubſtance. The Spar was found at the bottom in its natural ſtate. The ſmall quantity of iron contained in the Spar

occaſioned the eſcape of the volatile alkali, by uniting with the muriatic acid, and thus diſengaging the volatile alkali.

21. One part of Spar and two parts of *ſal ammoniacum Glauberi* were diſtilled. A volatile cauſtic alkali went firſt over; after which, a ſal ammoniac was ſublimated; the reſiduum was a ſelenite. In this experiment, the acid of ſpar united with the volatile alkali, and formed a ſal ammoniac *ſui generis*, (ſal ammoniacum ſpatoſum) which was the firſt ſubſtance that came over. The oil of vitriol of the *ſecreted* or *vitriolic ſal ammoniac*, by elective attraction united with the calcareous baſis of the Spar, and formed a ſelenite. When the new *Sparry ſal ammoniac* was diſſolved in water, and lime-water was poured to this ſolution, a regenerated ſpar was precipitated. The ſame phænomena happened from *ſal amarus*.

22. Spar being diſtilled with *corroſive ſublimate*, it was not in the leaſt changed, but a ſmall quantity of muriatic acid went over, proportioned to the ſmall quantity of iron contained in the Spar.

23. Spar diſtilled with the ſalt formed from a ſolution of mercury in the vitriolic acid, occaſioned a ſeparation of the acid of Spar, which therefore came over together with the globules of mercury; the iron in the Spar having ſaturated a ſmall quantity of acid of vitriol, occaſioned a proportioned quantity of quickſilver to riſe. The heat being encreaſed, the acid of Spar went likewiſe over; the vitriolic acid having ſeparated it from the iron; and of conſequence the reſiduum was of a red colour.

24. Sulphur and arſenic cauſed no change in the Spar.

SECTION IV.

Examination of the Acid of Spar, when ſeparated from its baſis.

25. THIS acid cannot be diſtinguiſhed by the ſmell from the muriatic acid; but it differs however materially from it; becauſe, when united with a calcareous earth, its common baſis, it forms a ſolid ſubſtance; whereas the muriatic acid of ſea-ſalt, when combined with ſuch a calcareous earth, remains always fluid.

26. This acid may be rectified by diſtillation, in a very gentle heat. That part of it which came over laſt was by much the ſtrongeſt, and formed a hard cruſt on the ſurface of that which came over firſt. The veſſels employed in the operation were corroded. The rectification being again repeated, the ſame appearances happened; from whence it may be concluded, that the whole acid may be converted, by the addition of water, into *ſilex.*

SECTION V.

Acid of Spar, when treated with Alkali.

27. THIS acid being mixed with oil of tartar, formed a gelatinous ſubſtance, which did not cryſtallize.

This being inſpiſſated to dryneſs, a ſaline maſs was left, which was about a ſixth part of the alkali originally employed. The ſyrup of violets did not change colour from this mixture. Lime-water being added to it, a precipitation of regenerated ſpar happened, and the ſupernatant liquor was an alkali diſſolved in water. The ſame precipitations were cauſed by the added ſolutions of *ſal ammoniacum fixum*, or of *ſal amarum*. The above gelatina being edulcorated, dried, melted in a crucible, and afterwards pounded, had a cauſtic taſte, ran *per deliquium* in a cellar, and was a true *liquor ſilicum*.

28. The ſame appearances happened, when the alkali employed was the *mineral fixed alkali*.

29. Volatile alkali being diſſolved in this acid, formed a gelatinous ſubſtance; which, after being decanted, edulcorated, and evaporated to dryneſs, proved to be a *ſilex*. The lixivium had a taſte ſomewhat ſimilar to *ſal ammoniacum Glauberi*. After evaporation, ſmall cryſtals were formed, with the following properties.

a. Being ſublimated, a volatile alkali at firſt went over, and afterwards a ſal ammoniac, with a very ſour taſte.

b. Being diſtilled with chalk and water, all the volatile alkali went over.

c. Theſe cryſtals being put into lime-water, a regenerated ſpar was precipitated.

d. The ſame thing happened upon the acid being added to a ſolution of *ſal ammoniacum fixum*, and the lixivium contained a common *ſal ammoniac*.

e. Theſe cryſtals being added to a ſolution of chalk in nitrous acid, a regenerated Spar was precipitated.

f. When they were added to a ſolution of ſilver in nitrous acid, a precipitation took place. This precipitate being melted into a ſolid ſubſtance, by means of the blowing-pipe, a white cruſt was formed upon the coal, around the regenerated ſilver.

This cruſt was a ſilex, formed by the union of the acid of Spar with the watery ſteams coming from the blowing-pipe, formed by breathing.

g. By adding theſe cryſtals to a ſolution of mercury, a precipitation was occaſioned; which was volatilized by heat.

A ſolution of corroſive ſublimate was not changed by the addition of theſe cryſtals.

h. When added to a ſolution of lead, the lead was precipitated.

i. A ſolution of ſal ammoniac became turbid from the addition of theſe cryſtals.

k. When the cryſtals were diſtilled with ſpirit of vitriol, a pure acid of Spar went over.

The regenerated Spar (of *c. d. e.*) was decompounded, by the addition of a mild alkali. In this experiment, the acid of Spar was attracted by the alkali; and the fixed air of the alkali was attracted by the calcareous earth of the ſpar, and formed a limeſtone. With cauſtic alkali no change was produced.

SECTION VI.

The Acid of Spar with abſorbent Earth.

30. THE acid of Spar being added to limewater, no precipitation took place, till the liquor was fully ſaturated; when a regenerated Spar was precipitated *Magneſia alba* was diſſolved by the acid of Spar; but, upon ſtanding for ſome time, part of the magneſia was precipitated, and the remainder formed a gelatinous ſubſtance.

With the *earth of alum*, a ſweet ſolution was formed, which, by ſtanding, turned into a gelatinous ſubſtance.

SECTION VII.

Acid of Spar with Metallic Subſtances.

31. THE following metals were digeſted for ſix hours in the acid of ſpar; and, towards the end of the operation, the heat was ſo much increaſed that the liquor boiled:

a. *Gold* was not in the leaſt affected by this acid, nor even upon adding to it ſpirit of nitre.

b. *Silver* was not acted upon; but its calx, precipitated from another acid by an alkali, was partly diſſolved.

c. *Quickſilver* was not affected by it; but its calx, precipitated from ſpirit of nitre by an alkali, was diſſolved; and the ſolution being evaporated to dryneſs, the remaining maſs was vitrified by means of heat with the blowing-pipe; but did not volatilize in the ſame heat.

d. *Lead* was not diſſolved by this acid; but its calx yielded a ſweet ſolution, from which the calx of lead could again be precipitated, by ſpirit of vitriol, ſpirit of nitre, or ſal ammoniac. Part of the above ſolution being evaporated to dryneſs, yielded by the blowing-pipe a glaſs, as in the next preceding experiment.

e. *Copper* was in part diſſolved by it, and this ſolution ſtruck the ſpirit of ſal ammoniac. The calx of copper diſſolved eaſily, and this ſolution formed firſt blue cryſtals, and the remaining liquor turned gelatinous.

f. The acid of ſpar acted with great violence upon *iron*; and the fumes occaſioned during the operation were inflammable, the taſte of the ſolution ſimilar to vitriol of iron. It did not cryſtallize, but turned gelatinous. If, inſtead of iron, *ochre* or its calx were employed, the ſame appearances happened.

g. *Tin* in its metallic form was not acted upon, but its calx was eaſily diſſolved, and the ſolution became gelatinous.

h. *Biſmuth* was not diſſolved, but the calx of biſmuth had the ſame appearances as that of lead.

i. *Zinc* was diſſolved in the ſame manner as iron, and the ſolution partly cryſtallized.

k. *Cobalt* was not affected, but its calx was diſſolved, and turned gelatinous.

l. *Regulus antimonii* was not acted upon, nor was the powder of *vitrum antimonii*.

SECTION VIII.

Acid of Spar, with Saline Solutions.

32. *a*. The acid of ſpar being added to a ſolution of ſilver, a ſmall precipitation was obſerved.

b. Quickſilver diſſolved in nitrous acid was partly precipitated by the addition of acid of ſpar; and the precipitate being melted by the blowing-pipe, was volatilized.

c. The ſolution of corroſive ſublimate was not changed by it.

d. This acid being added to a ſolution of lead, in ſpirit of nitre, no precipitation happened.

e. From a ſolution of lead in vinegar a calx was precipitated, which was again diſſolved upon adding a greater quantity of acid of ſpar.

f. The ſolutions of vitriol of iron, of copper, and of zinc, and likewiſe thoſe of alum and ſal amarum, were not affected by this acid.

33. From what has been ſaid it appears, that,

a. The *ſiliceous* or *flinty earths* are ſoluble in the acid of ſpar.

b. That this earth is precipitated upon the addition of other ſubſtances.

c. That the regenerated ſpar (10) was not quite pure, but contained a ſmall quantity of ſilex. This however does not contradict what was there ſtated; becauſe the ſilex, being decompounded, muſt always remain with the regenerated gypſum.

d. Acid of ſpar can ſcarcely be obtained pure, as it always contains a ſmall quantity of ſilex.

e. This however can always be precipitated by the addition of an alkali; ſo that we can always be certain as to the baſis with which the acid is united.

f. The acid of ſpar being combined with an alkali, will diſſolve a ſubtle powder of ſilex (27).

FINIS.

PROF. Torbern Bergman, Mr. C. W. Scheele, and Mr. J. G. Gahn, have lately, by a ſeries of curious and intereſting Experiments, ſucceeded in Analyſing and Regenerating the following Mineral Subſtances; viz. *Zeolites*, *Garnets*, *Cockle*, *Quartz*, *Feld-Spar* or *Rhombic Quartz* (Cronſtedt's Mineral. Sect. LXVI.), *Soaprock*, and *Black-lead*. The reſult of their Experiments will be inſerted in the Memoirs of the Swediſh Royal Academy of Sciences; and by this means a new light will be thrown on Mineralogy, and the method of ranging and claſſing Mineral Bodies ſyſtematically will be greatly facilitated.